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Beyond the Hype: Do Industry 4.0 Competencies Improve Job Performance? Empirical Evidence from the Omani Public Sector

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Abstract: The Fourth Industrial Revolution (Industry 4.0) is transforming the workplace and increasing the need for employees to acquire new skills to remain effective, flexible, and productive within their organizations. While existing research suggests that Industry 4.0 skills positively influence employee performance, empirical evidence from the public sector and non-Western regions remains limited. This study fills that gap by exploring how three key Industry 4.0 competencies—Collaboration, Critical Thinking, and Stay Relevant—affect Job Performance in the Omani public sector. It also examines how Leadership Support moderates these relationships. The research is based on Socio-Technical Systems Theory, Human Capital Development Theory, the Resource-Based View, and Contingency Theory. Using a quantitative cross-sectional approach, data were collected through an online questionnaire from 130 employees across various Omani ministries and government agencies. The three competency constructs were modeled as second-order reflective constructs: Collaboration included Customer Orientation, Developing People, Communication, Building Inclusivity, and Influence; Critical Thinking encompassed Creative Thinking, Decision-Making, Sense-Making, Problem-Solving, and Transdisciplinary Thinking; Stay Relevant involved Adaptability, Digital Fluency, Global Perspective, Learning Agility, and Self-Management. Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM), with 10,000 bootstrap resamples and a 90% confidence level, following established methods for variance-based SEM. The results confirmed that the measurement model demonstrated good reliability and validity. Consistent with theoretical expectations, all three competencies showed positive links to Job Performance. Regarding Leadership Support's moderating role, the results indicated a targeted effect: it significantly strengthened the positive impact of Collaboration on Job Performance, whereas its influence on Critical Thinking and Stay Relevant was not statistically significant. The study adds to existing knowledge by being among the first to empirically test this set of Industry 4.0 competencies in a non-Western public sector context, illustrating that frameworks developed for Industry 4.0 can produce meaningful performance benefits even in complex institutional environments—though such effects depend on organizational support and leadership conditions. Practically, the findings emphasize the need to focus on developing collaboration skills, enhancing leadership practices, updating performance management systems to recognize Industry 4.0 behaviors, and creating organizational environments that facilitate the effective application of Critical Thinking and Stay Relevant competencies to improve measurable performance outcomes.

Keywords: Industry 4.0 Skills; Competencies; Job Performance; Collaboration; Critical Thinking; and Stay Relevant; Leadership Support.

1. Introduction

The Fourth Industrial Revolution (Industry 4.0) is fundamentally reshaping

the global economy, redefining the nature of work, and intensifying demand for a workforce equipped with advanced, future-relevant competencies. Driven by transformative technologies such as artificial intelligence, automation, the Internet of Things, and sophisticated data analytics, Industry 4.0 is not merely a technological phenomenon but a profound structural shift in how organizations operate, how value is created, and how employees are expected to perform (Li, 2022; Ozkan-Ozen & Kazancoglu, 2022). As these technologies continue to penetrate both the private and public sectors, the competencies required for effective job performance are evolving at an unprecedented pace, placing considerable pressure on individuals, organizations, and governments to respond urgently and with strategic coherence (Khan et al., 2021; Khalid & Ahmad, 2021).

The scale of this disruption is well documented. The World Economic Forum projects that by 2027, 44% of core workforce skills will be significantly disrupted, and approximately half of all employees globally will require reskilling to remain productive and relevant in their roles (Schwab & Zahidi, 2023) (Al-Haimi et al., 2024). Yet only half of the global workforce currently has access to adequate training and development opportunities, creating a widening skills gap that threatens organizational performance and national productivity alike. In response, scholars and practitioners increasingly emphasize that workforce effectiveness in the Industry 4.0 era demands not only technical proficiency but also higher-order capabilities such as critical thinking, collaborative problem-solving, adaptability, and continuous learning, competencies that enable employees to navigate complexity, drive innovation, and sustain performance in rapidly changing work environments (Pontes et al., 2021; Auer & Centea, 2021).

Despite the theoretical prominence of Industry 4.0 competencies in the workforce development literature, empirical evidence examining their direct relationship to employee job performance remains surprisingly limited, particularly in public-sector and non-Western organizational contexts. The majority of existing studies focus on manufacturing, technology, and private-sector settings in developed economies, leaving a significant gap in understanding how these competencies operate and translate into performance outcomes within the distinctive structural, cultural, and institutional conditions of public-sector organizations in developing and emerging economies. This gap is both theoretically and practically significant, as public-sector performance is central to national development, service delivery quality, and the realization of broader economic transformation agendas.

Nowhere is this gap more pronounced than in the Sultanate of Oman, where the advancement of Industry 4.0 presents both a compelling strategic opportunity and a complex institutional challenge. Guided by Vision 2040, Oman has committed to transitioning toward a knowledge-based, innovation-driven economy through sustained investment in human capital and the modernization of its public institutions (Foundation, 2004). The public sector plays a central role in this transformation agenda, serving as both a primary employer of Omani nationals and a critical vehicle for delivering the institutional reforms needed to achieve national development objectives. However, realizing this ambition fundamentally depends on equipping the public sector workforce with the competencies needed to operate effectively in a digitally enabled environment characterized by automation, data-driven decision-making, and continuous technological change.

The challenge is considerable. A persistent and well-documented skills mismatch exists between the competencies of Omani nationals and the capabilities demanded

by an Industry 4.0-transformed labor market (Hinai et al., 2020; Langthaler et al., 2022; Al Harrasi et al., 2023). This mismatch is compounded by Oman's socio-economic context as a rentier state, where public-sector employment has historically been preferred, and reliance on expatriate labor has reduced incentives for sustained investment in the skill development of local talent (Emerson, 2020). Ajaham and Hamid (2023) note that both the public and private sectors have largely relied on foreign labor to meet development goals due to insufficient competencies among Omani citizens, a dependency that undermines the efficiency, adaptability, and long-term sustainability of public services. Rawas and Jantan (2022) similarly report a notable performance gap between Omani public-sector employees and their international counterparts, emphasizing the urgent need for targeted competency enhancement, training reform, and institutional modernization.

Compounding these workforce development challenges are broader organizational and human resource management concerns. Studies in the Omani public sector context reveal that career development programs, training quality, and performance appraisal practices significantly affect employee productivity and retention, yet poor execution of human resource strategies often leads to diminished morale and underperformance (Al-Harthy & Yusof, 2022; Saadouli & Al-Khanbashi, 2021). Balushi et al. (2022) further note that although public sector employees in Oman exhibit strong job retention, overall job satisfaction remains low, indicating a disconnect between organizational commitment and actual performance outcomes. Almawali (2021) and Haziazi (2024) also highlight that motivational factors, organizational support, and recognition mechanisms are critical antecedents of employee engagement and performance, yet these human factors remain substantially underexplored in the Omani public sector context.

Against this backdrop, the COVID-19 pandemic has further accentuated structural vulnerabilities and underscored the urgent need for more resilient, adaptive, and digitally oriented upskilling strategies across the Omani workforce (Mimoune & Kabbani, 2025). The intersection of pandemic-induced disruption, Vision 2040 imperatives, and the accelerating pace of Industry 4.0 adoption creates a uniquely consequential context in which understanding the relationship between workforce competencies and job performance is both immediately practical and strategically enduring.

This study addresses these challenges by empirically examining the relationship between three key Industry 4.0 competency constructs (Collaboration, Critical Thinking, and Stay Relevant) and Job Performance among employees in the Omani public sector. Drawing on a major Singapore government study on the future readiness of public sector employees (Freebody, 2023), each competency is operationalized within a multidimensional, second-order framework. Collaboration encompasses the ability to work inclusively with others, build consensus, and influence outcomes through interpersonal effectiveness, measured across five dimensions: building inclusivity, fostering collaboration, customer orientation, developing others, and influencing stakeholders. Critical Thinking reflects the capacity to analyze complex information, make reasoned judgments, and solve problems creatively, operationalized through communication, creative thinking, decision-making, sense-making, problem-solving, and transdisciplinary thinking. Stay Relevant captures future-oriented capability through continuous learning and adaptability, assessed across adaptability, digital fluency, global perspective, learning agility, and self-management. Job Performance is measured using the Individual Work Performance

Questionnaire (IWPQ), which evaluates task performance, contextual performance, and counterproductive work behavior. The study further investigates the moderating role of Leadership Support, grounded in the public leadership model of Tummers and Knies (2016), which encompasses four public-sector-specific leadership roles: accountability leadership, rule-following leadership, political loyalty leadership, and network governance leadership.

The study is grounded in Socio-Technical Systems Theory, Human Capital Development Theory, the Resource-Based View, and Contingency Theory, providing a multi-theoretical foundation for understanding how Industry 4.0 competencies translate into performance outcomes in the complex institutional environment of the Omani public sector. By integrating these perspectives with rigorous empirical analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM), the study aims to generate both theoretical contributions and policy-relevant insights that advance understanding of Industry 4.0 workforce competencies beyond the predominantly Western and private-sector contexts in which they have thus far been examined.

The remainder of this paper is organized as follows. Section 2 presents the theoretical background and develops the hypotheses. Section 3 describes the research methodology. Section 4 reports the empirical findings. Section 5 discusses the results in relation to the literature and theoretical frameworks. Section 6 concludes with the study's contributions, practical implications, limitations, and directions for future research.

2. Literature Review and Hypotheses Development

2.1 Theoretical Underpinnings

This study is grounded in four complementary theoretical frameworks that together provide a robust, multi-layered foundation for examining how Industry 4.0 competencies influence job performance in the Omani public sector and how leadership moderates these relationships. The conceptual model of the study is presented in **Figure 1**. The integration of Socio-Technical Systems Theory, Human Capital Development Theory, the Resource-Based View, and Contingency Theory reflects the human, technical, strategic, and situational dimensions of the competency–performance relationship in a complex institutional context.

Socio-Technical Systems Theory (STS) holds that optimal organizational performance arises from aligning social systems, encompassing people, structure, and culture, with technical systems, including tools, processes, and technologies (Trist & Bamforth, 1951; Pasmore, 1988). In this study, Collaboration is framed within STS as a construct that captures the social dimension of work systems, particularly how individuals and teams interact in technologically evolving environments. As the Omani public sector undergoes an accelerating digital transformation, collaborative competency increasingly mediates the interface between human capability and technological infrastructure. STS, therefore, provides a theoretical rationale for expecting Collaboration to positively influence job performance, particularly in environments where social and technical systems are becoming increasingly integrated.

Human Capital Development Theory (HCDDT) holds that employees' knowledge, skills, and abilities are critical organizational assets that must be deliberately developed to enhance individual and organizational productivity (Becker, 1989; Schultz, 1961). This study applies HCDDT to Critical Thinking and Stay Relevant,

both conceptualized as essential Industry 4.0 competencies that require sustained investment to develop and maintain. HCDDT provides the rationale for expecting that higher levels of these competencies will translate into stronger job performance outcomes, and aligns directly with Oman Vision 2040's strategic priority of upskilling the public sector workforce to meet the demands of a knowledge-based economy.

The Resource-Based View (RBV) emphasizes that internal capabilities that are valuable, rare, inimitable, and non-substitutable serve as sources of sustained competitive advantage (Barney, 1991; Wernerfelt, 1984). In the public-sector context of this study, Industry 4.0 competencies, including collaborative capability, critical reasoning, digital fluency, and learning agility, are conceptualized as strategic human resources that, when developed and embedded in the workforce, can enhance the quality and effectiveness of public service delivery. RBV supports the proposition that investing in these competencies yields meaningful performance returns, while also highlighting that their value is contingent on the organizational conditions through which they are leveraged and applied.

Contingency Theory holds that organizational effectiveness depends not on universal management principles but on the fit between internal structures, leadership behaviors, and contextual conditions (Lawrence & Lorsch, 1967; Fiedler, 1964). In this study, Leadership Support is treated as a moderator grounded in Contingency Theory, on the premise that the extent to which employees translate their Industry 4.0 competencies into job performance depends on the nature and quality of leadership support available to them. Leadership is operationalized through Tummers and Knies' (2016) public leadership model, which identifies four public-sector-specific leadership roles: accountability leadership, rule-following leadership, political loyalty leadership, and network governance leadership. Contingency Theory provides the theoretical basis for expecting that Leadership Support will strengthen the competency–performance relationship, while also allowing for the possibility that its moderating influence may be selective and context-dependent.

2.1.1 Justification for the Higher-Order Construct Approach

As depicted in **Figure 1**, the three Industry 4.0 competency constructs, Collaboration, Critical Thinking, and Stay Relevant, are operationalized as second-order reflective models, each reflected through multiple first-order dimensions. This modeling decision is grounded in both theoretical and methodological considerations that warrant explicit articulation in response to the reviewer's comment.

Theoretically, the higher-order modeling approach reflects the fundamental nature of Industry 4.0 competencies as integrative, multidimensional capability domains rather than collections of discrete, independent skills. The competency framework adopted in this study is drawn from the Institute for Adult Learning Singapore's Critical Core Skills framework (Freebody, 2023), which explicitly conceptualizes Collaboration, Critical Thinking, and Stay Relevant as broad, holistic workforce competencies that encompass multiple interrelated behavioral and cognitive dimensions. Treating these constructs as higher-order rather than analyzing their first-order dimensions separately preserves the framework's theoretical integrity and captures the integrative nature of competency as it is understood, assessed, and developed in workforce practice. This approach is consistent with the broader competency literature, which holds that professional competencies are not simply additive collections of sub-skills but rather emergent capabilities whose collective expression is greater than the sum of their individual parts (Boyatzis, 1982; McClelland, 1973). In Industry 4.0 contexts specifically, scholars have argued that

the competencies required for effective workforce performance are fundamentally multidimensional and integrative, requiring employees to draw on and combine multiple cognitive, interpersonal, and adaptive capabilities in dynamic and complex work environments (Ozkan-Ozen & Kazancoglu, 2022; Schleicher, 2015).

Methodologically, the second-order reflective modeling approach is well-established and appropriate for behavioral and social science research in which the latent construct is conceptually broader than any single indicator and in which the first-order dimensions are expected to be internally consistent and highly correlated manifestations of the same overarching competency (Hair et al., 2023; Sarstedt et al., 2019). In PLS-SEM, higher-order constructs are particularly recommended when the theoretical domain of interest is broad and multifaceted, and when the research objective is to examine the overall competency domain's relationship with outcome variables rather than to assess the differential contributions of individual sub-dimensions (Ringle et al., 2020; Hair et al., 2023). This approach also reduces model complexity and the risk of multicollinearity that would arise from simultaneously entering all first-order dimensions as separate predictors in the structural model, thereby enhancing the parsimony and interpretability of the results.

It is acknowledged, however, that aggregating first-order dimensions into a single higher-order construct may partially obscure the differential performance contributions of individual dimensions. As noted in the limitations of this study, certain dimensions, such as decision-making and problem-solving within Critical Thinking, or learning agility and digital fluency within Stay Relevant, may carry stronger individual relationships with job performance than the aggregated construct reveals. Future research that tests first-order dimensions separately would therefore provide valuable complementary insights into the specific aspects of each competency that are most directly relevant to performance improvement in public-sector settings.

2.2 Job Performance

Job performance is widely regarded as the most consequential individual-level outcome in organizational research, reflecting the extent to which employees fulfill their designated responsibilities and contribute to organizational effectiveness (Koopmans et al., 2013). It is broadly defined as an individual's proficiency in carrying out tasks specified in their job description, encompassing the completion of core responsibilities, the execution of activities pertinent to their role, and the demonstration of behaviors that support the broader functioning of the organization (Kappagoda, 2018; Nwokike & Unegbu, 2019). In the Industry 4.0 era, the concept of job performance has evolved beyond narrow task completion to encompass a broader set of behavioral dimensions that reflect employees' capacity to adapt, collaborate, and contribute proactively to organizational goals in dynamic, technology-rich work environments.

This study adopts the multidimensional conceptualization of job performance proposed by Koopmans et al. (2013) and operationalized through the Individual Work Performance Questionnaire (IWPQ), which captures three distinct behavioral dimensions. Task performance refers to the proficiency with which employees execute the core duties and responsibilities central to their designated roles. Contextual performance encompasses discretionary behaviors that extend beyond formal role requirements, including voluntary cooperation, interpersonal support, and proactive contributions to organizational functioning. Counterproductive work behavior captures actions that are harmful to the organization or its members, included to provide a comprehensive and balanced assessment of employee performance.

Together, these three dimensions offer a theoretically grounded and empirically validated framework for measuring job performance that is well-suited to the public sector context of this study.

2.3 Industry 4.0 Competencies and Job Performance

2.3.1 Collaboration

Collaboration has emerged as one of the most important competencies for effective workforce participation in Industry 4.0 environments, where rapid automation, digitalization, and artificial intelligence breakthroughs demand employees who can work inclusively, build consensus, and achieve coordinated outcomes in complex, multidisciplinary settings (Ozkan-Ozen & Kazancoglu, 2022; Tan & Isa, 2024; Gupta et al., 2022). The transition to Industry 4.0 requires not only technical proficiency but also strong interpersonal and team-based competencies to navigate cross-functional challenges and drive collective innovation (Khan et al., 2021).

In this study, Collaboration is operationalized as a second-order reflective construct comprising five first-order dimensions: Building Inclusivity, Communication, Customer Orientation, Developing People, and Influence. This multidimensional conceptualization reflects the breadth of collaborative competency as defined in the Singapore public sector Critical Core Skills framework (Freebody, 2023) and captures the full range of interpersonal, relational, and organizational behaviors through which collaborative capability manifests in the workplace.

The positive relationship between collaboration and job performance is well established in the organizational behavior literature. Inclusive practices, a core component of collaborative competency, foster workplace cultures where diverse perspectives are acknowledged and valued, thereby enhancing employee motivation, engagement, and performance (Rijal, 2023; Gupta et al., 2022; Alshammari & Ali, 2024). Customer orientation, a subdimension of collaboration, also plays an important role in shaping performance outcomes in service environments, where anticipating and satisfying stakeholder needs directly strengthens the link between collaborative engagement and organizational effectiveness (Tan & Isa, 2024; O'Brien & O'Toole, 2021; Guo et al., 2022). The influence dimension of collaborative competency also has significant performance implications, as leadership behaviors grounded in inclusivity and psychological empowerment are known to enhance employee well-being, trust, commitment, and goal alignment (Nguyen et al., 2019; Umrani et al., 2023; Lee et al., 2022).

Drawing on Socio-Technical Systems Theory, which emphasizes the importance of aligning social and technical dimensions of work for optimal performance outcomes, and supported by the empirical evidence reviewed above, this study proposes:

H1: There is a positive and significant relationship between Collaboration and Job Performance in the Omani public sector.

2.3.2 Critical Thinking

Critical thinking has become an indispensable competency in Industry 4.0 environments, where rapid technological change and data-driven decision-making demand higher-order cognitive processes such as analysis, reasoning, creative problem-solving, and transdisciplinary integration (Malik et al., 2019; Law et al., 2021). Alongside digital fluency and adaptability, critical thinking has consistently been identified as one of the most essential competencies for future workforce

effectiveness across sectors (World Economic Forum, 2020).

In this study, Critical Thinking is operationalized as a second-order reflective construct comprising five first-order dimensions: Creative Thinking, Decision-Making, Problem-Solving, Sense-Making, and Transdisciplinary Thinking. Creative Thinking enables employees to generate novel ideas, challenge conventional assumptions, and propose innovative solutions. Empirical studies show that organizations that foster creativity achieve improved job performance through enhanced intrinsic motivation and organizational commitment (Aigbogun et al., 2024). Decision-Making empowers individuals to evaluate alternatives systematically and make well-informed choices under uncertainty, a competency closely linked to accountability and performance quality in public administration contexts (Pedraja-Rejas et al., 2025; Khoshgoftar & Barkhordari-Sharifabad, 2023). Problem-Solving reflects the pragmatic application of critical reasoning to resolve workplace challenges, with evidence highlighting its mediating role in reducing job-related stress and enhancing organizational efficiency (Aigbogun et al., 2024; Göğüş et al., 2020). Sense-Making equips employees to interpret complex and ambiguous information, enabling strategic judgment in data-rich Industry 4.0 contexts (Ulubey & Alpaslan, 2022). Transdisciplinary Thinking, the ability to integrate knowledge across disciplinary boundaries, supports flexible and innovative professional practice in multifaceted organizational environments (Law et al., 2021).

Grounded in Human Capital Development Theory, which posits that investment in cognitive competencies generates measurable returns in individual and organisational performance, and supported by consistent empirical evidence linking critical thinking to enhanced job outcomes across diverse occupational settings (Ateş et al., 2023; Khas et al., 2023), this study proposes:

H2: There is a positive and significant relationship between Critical Thinking and Job Performance in the Omani public sector.

2.3.3 Stay Relevant

Stay Relevant reflects an individual's ongoing capacity to adapt, learn, and align with evolving work demands amid rapid technological and organizational change (Freebody, 2023). In Industry 4.0 environments, where the half-life of skills is accelerating and the nature of work is continually transformed by automation and digitalization, maintaining workforce relevance through ongoing learning and adaptability has become a fundamental driver of sustained job performance (World Economic Forum, 2020; DeNisi & Murphy, 2017).

In this study, Stay Relevant is operationalized as a second-order reflective construct comprising five first-order dimensions: Adaptability, Digital Fluency, Global Perspective, Learning Agility, and Self-Management. Adaptability is widely recognized as a cornerstone of workforce effectiveness, enabling employees to manage uncertainty, navigate technological disruption, and assume evolving roles and responsibilities. Empirical evidence consistently links it to improved job performance across sectors (Pala'langan & Satrya, 2023; Park & Park, 2020; Chong & Zainal, 2024). Digital fluency, the ability to strategically and seamlessly leverage digital tools, has become indispensable in technology-driven workplaces, with research demonstrating a strong relationship between digital competency and job effectiveness in the public administration, healthcare, and logistics sectors (Ntule et al., 2024; Zielińska, 2022; Huu, 2023). A global perspective equips employees to engage effectively across cultural contexts and in accordance with international standards, complementing adaptability by providing the mindset needed to interpret global

trends and contribute to innovation in interconnected organizational environments (Jannesari & Sullivan, 2019; Liao et al., 2021). Learning agility, the capacity to learn from experience and apply new knowledge in novel situations, is strongly associated with proactive career development, job crafting, and sustained performance improvement (Park et al., 2020; Wolor et al., 2025; Serena et al., 2025). Self-management, encompassing the regulation of time, energy, and motivation to meet objectives with limited external supervision, is foundational to sustained performance in autonomous and flexible work environments. Evidence links it to stronger learning agility and adaptive capacity in digital workplaces (Untari et al., 2021; Saputra, 2024, 2025).

Grounded in both Human Capital Development Theory and the Resource-Based View, which collectively emphasise that continuously developed and strategically embedded competencies generate sustained performance returns, this study proposes:

H3: There is a positive and significant relationship between Stay Relevant and Job Performance in the Omani public sector.

2.4 The Moderating Role of Leadership Support

Leadership support is widely recognized as a critical organizational enabler that shapes the conditions under which employee competencies are developed, expressed, and translated into performance outcomes (Bass & Avolio, 1994; Graen & Uhl-Bien, 1995). In this study, Leadership Support is operationalized using Tummers and Knies' (2016) public leadership model, which captures four roles specific to public-sector leadership: accountability leadership, rule-following leadership, political loyalty leadership, and network governance leadership. This public-sector-specific conceptualization is particularly appropriate for the Omani context, where leadership is embedded within formal administrative structures and shaped by distinct institutional norms and governance traditions.

Empirical evidence consistently demonstrates that supportive leadership strengthens the relationship between employee competencies and performance outcomes. Sürücü et al. (2022) demonstrated that Leadership Support serves as a meaningful boundary condition that amplifies performance outcomes by bolstering employee self-efficacy. Hai (2024) similarly found that supportive leadership is positively associated with management effectiveness in public project organizations, while Jakobsen et al. (2021) showed that Leadership Support maximizes the performance effects of distributed leadership in public sector teams. Gebremedhn et al. (2022) further established that perceived organisational support strengthens the positive effects of human capital dimensions on job performance, though not uniformly across all competency types, a finding that has important theoretical implications for the selective moderating effects examined in this study.

In Industry 4.0 contexts, Leadership Support plays a critical enabling role in helping employees leverage emerging competencies to improve performance (Liao, 2017). Leaders who actively model collaborative behavior, create psychologically safe environments, encourage experimentation, and align developmental opportunities with organizational goals are better positioned to amplify the performance benefits of competencies such as Collaboration, Critical Thinking, and Stay Relevant (Edmondson, 1999; Han et al., 2020; Haryanto et al., 2022). Grounded in Contingency Theory, which holds that leadership effectiveness is situationally determined and depends on the fit between leadership behavior and the specific competencies and performance demands of the organizational context, this study proposes:

H4: Leadership Support positively moderates the relationship between

Collaboration and Job Performance in the Omani public sector, such that the relationship is stronger when Leadership Support is high.

H5: Leadership Support positively moderates the relationship between Critical Thinking and Job Performance in the Omani public sector, such that the relationship is stronger when Leadership Support is high.

H6: Leadership Support positively moderates the relationship between Stay Relevant and Job Performance in the Omani public sector, such that the relationship is stronger when Leadership Support is high.

This review synthesizes the existing literature on the critical competencies identified as essential for success in the Industry 4.0 era, specifically examining their relevance and impact in public-sector contexts. The following sections examine adaptability, digital fluency, global perspective, learning agility, and self-management, analyzing their theoretical underpinnings and empirical evidence for their role in enhancing job performance (see **Figure 2.1**).

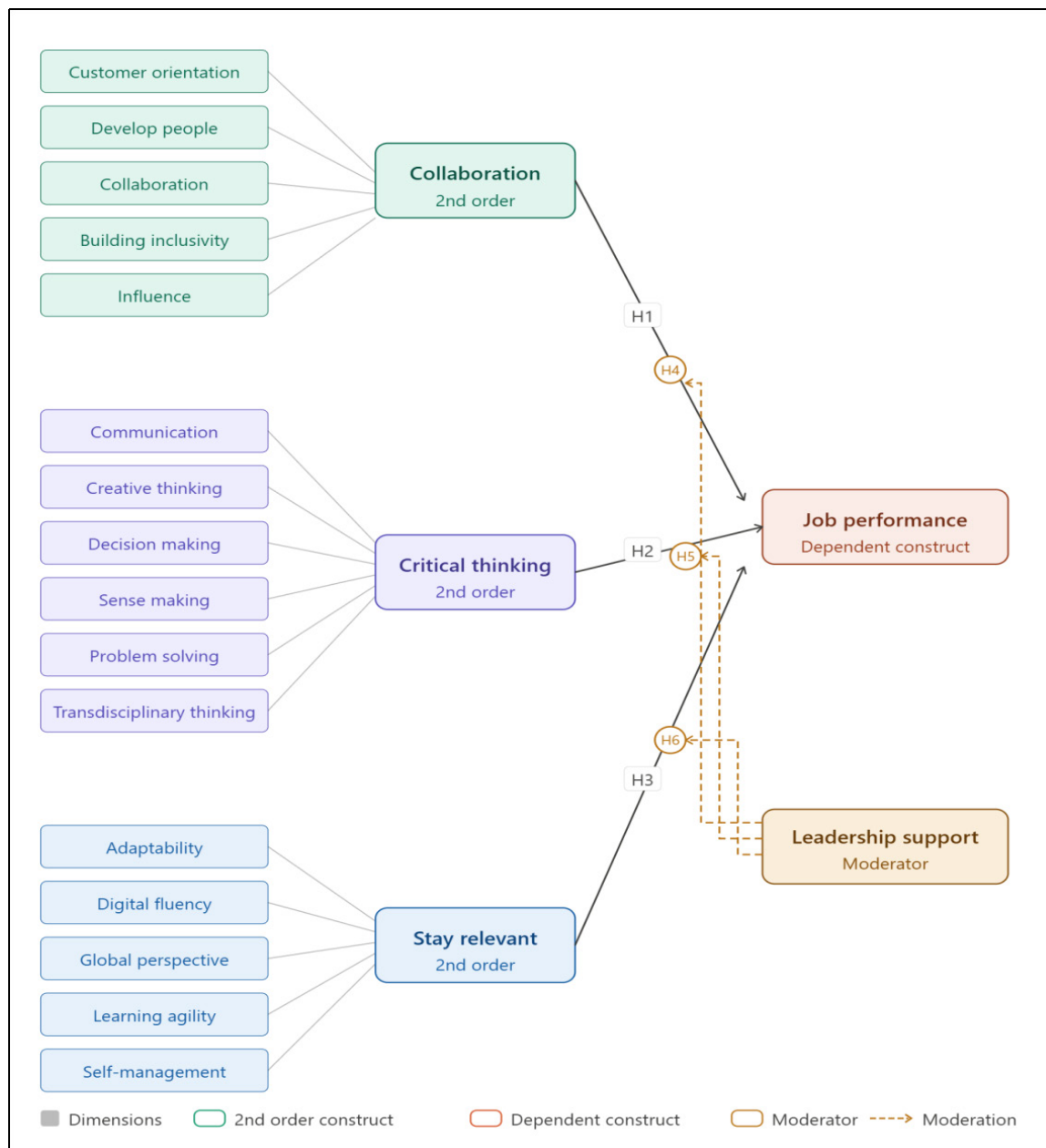


Figure 2.1. Study Framework

3. Methodology and Measurements

This study employs a quantitative, cross-sectional, explanatory research design to systematically examine the relationships between three Industry 4.0 competency constructs (Collaboration, Critical Thinking, and Stay Relevant) and Job Performance among employees in the Omani public sector, and to test the moderating role of Leadership Support. A quantitative approach was adopted for its capacity to produce objective, statistically testable findings aligned with the positivist research paradigm and its suitability for hypothesis testing and the examination of causal relationships among predefined constructs (Creswell & Creswell, 2018). The unit of analysis is the individual public-sector employee, with data collected at a single point in time, consistent with a cross-sectional time horizon.

The study targets employees across four key Omani ministries, including the Ministry of Labor, the Ministry of Economy, the Ministry of Health, and the Ministry of Transport and Communication, selected for their central roles in national development and the implementation of Vision 2040 digital transformation initiatives. A stratified random sampling technique was employed to ensure proportional representation across ministries and functional units, minimizing sampling bias and enhancing the generalisability of the findings. A total of 130 valid responses were obtained. Sample size adequacy was confirmed through a G*Power a priori power analysis, which indicated a minimum requirement of 103 respondents based on a medium effect size ($f^2 = 0.15$), a statistical power of 0.80, and a significance level of $\alpha = 0.05$, a threshold comfortably exceeded by the final sample.

Data were collected through a structured online questionnaire comprising validated scales for each construct. Job Performance was measured using the 18-item Individual Work Performance Questionnaire (IW PQ) developed by Pedro and Juan (2019), capturing task performance, contextual performance, and counterproductive work behaviour. The three Industry 4.0 competency constructs (Collaboration, Critical Thinking, and Stay Relevant) were operationalized as second-order reflective constructs using measurement items derived from the Institute for Adult Learning Singapore competency framework (Freebody, 2023). Leadership Support was measured using items adapted from Zhao, J., Liu, T., & Liu, Y. (2024). Full details of all measurement items are provided in the Appendix. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with 10,000 bootstrapping resamples and a 90% confidence interval, in accordance with established guidance for variance-based structural equation modeling (Hair et al., 2019).

3.1 Data Analysis and Results

The data were initially cleaned and prepared for analysis. Descriptive statistics were used to profile the respondents. To evaluate the measurement model, reliability and validity tests, including Composite Reliability (CR) and Average Variance Extracted (AVE), were performed, along with discriminant validity assessment using the Heterotrait–Monotrait (HTMT) ratio. For hypothesis testing, Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to examine both the direct effects of the three Industry 4.0 competency constructs on Job Performance and the moderating role of Leadership Support. Statistical significance was determined through bootstrapping with 10,000 resamples and a 90% confidence interval, in accordance with established guidance for variance-based structural equation modeling (Hair et al., 2023).

4. Results

4.1 Demographic Profile of Respondents

Table 4.1 presents the demographic profile of the 130 respondents. The sample is predominantly composed of mid-to-senior career professionals, with the majority aged between 36–45 years (53.8%), followed by those aged 46–55 (32.3%). Only 10.0% fell within the 25–35 age bracket, and 3.8% were aged 56 and above. In terms of gender, the sample was heavily male-dominated, with 90.8% male respondents compared to 9.2% female, a distribution that broadly reflects the structural composition of the public sector workforce at senior and supervisory levels in Oman.

Regarding organisational affiliation, respondents were drawn from a diverse range of public sector entities. The largest group identified with other ministries or government entities not explicitly listed (51.5%), followed by other organisations (17.7%). Among the named ministries, the Ministry of Public Service was most represented (12.3%), followed by the Ministry of Education (7.7%), Ministry of Health (4.6%), Ministry of Labour (3.8%), and Ministry of Finance (2.3%). In terms of role, supervisory positions were most prevalent (29.2%), followed by administrative (26.2%), technical (16.9%), other (16.2%), and managerial roles (11.5%), reflecting a broad cross-section of functional positions within Omani public sector organisations.

The sample is notably experienced, with an overwhelming 94.6% of respondents reporting more than ten years of public sector experience, underscoring that the findings are grounded in the perspectives of highly tenured employees. Finally, 96.2% of respondents were local nationals, consistent with the Omanisation policies prevalent across Gulf public sector institutions and lending contextual coherence to the study's findings.

Table 4.1. Demographic Profile of Respondents (n = 130)

Variable	Category	Frequency (n)	Percentage (%)
Age	25–35	13	10.0
	36–45	70	53.8
	46–55	42	32.3
	56 and above	5	3.8
	Total	130	100.0
Gender	Male	118	90.8
	Female	12	9.2
	Total	130	100.0
Ministry / Organisation	Other Ministries/Entities	67	51.5
	Other (Please Specify)	23	17.7
	Ministry of Public Service	16	12.3
	Ministry of Education	10	7.7
	Ministry of Health	6	4.6
	Ministry of Labour	5	3.8

Continuation Table:

Variable	Category	Frequency (n)	Percentage (%)
Position / Role	Ministry of Finance	3	2.3
	Total	130	100.0
	Supervisory	38	29.2
	Administrative	34	26.2
	Technical	22	16.9
	Other	21	16.2
	Managerial	15	11.5
	Total	130	100.0
Years of Experience	Less than 1 year	3	2.3
	1–5 years	4	3.1
	More than 10 years	123	94.6
	Total	130	100.0
Nationality	Local	125	96.2
	International	5	3.8
	Total	130	100.0

4.2 Measurement Model Assessment

Before analyzing the structural relationships, the measurement model was evaluated to confirm the reliability and validity of all latent constructs. Based on recognized PLS-SEM guidelines, this assessment included indicator reliability, internal consistency, convergent validity, and discriminant validity (Hair et al., 2021). The summarized results are presented in **Figure 4.1** and **Tables 4.2** and **4.3**.

4.2.1 Indicator Reliability and Internal Consistency

Item reliability was assessed using the outer loadings for all items. As shown in Table 4.2, the majority of loadings exceeded the recommended threshold of 0.70, confirming satisfactory item reliability. A small number of items fell marginally below this threshold, notably BUINC1 (0.723), INF5 (0.738), and DM1 (0.685), but were retained due to their theoretical importance and the overall satisfactory validity of their respective constructs, consistent with guidance from Hair et al. (2023). Internal consistency was evaluated using Composite Reliability (CR). All constructs exceeded the recommended minimum of 0.70, with values ranging from 0.864 for Stay Relevant to 0.958 for Job Performance, and 0.953 for Leadership Support, confirming strong and consistent measurement across all constructs.

4.2.2 Convergent Validity

Convergent validity was assessed using Average Variance Extracted (AVE). As presented in Table 4.2, all constructs achieved AVE values at or above the recommended threshold of 0.50. Values ranged from 0.556 for Critical Thinking to 0.828 for Leadership Support, with Collaboration at 0.603, Stay Relevant at 0.564, and Job Performance at 0.660. These results confirm that each construct explains

a sufficient proportion of variance in its associated indicators, supporting adequate convergent validity across the measurement model.

4.2.3 Discriminant Validity

Discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio, widely recognised as a robust criterion for evaluating construct distinctiveness in PLS-SEM (Henseler et al., 2015; Ramayah et al., 2018). As shown in Table 4.3, Leadership Support demonstrated clear discriminant validity relative to all other constructs, with HTMT values consistently below 0.51 across all pairs. Several construct pairs involving the Industry 4.0 competency constructs, particularly Stay Relevant and Critical Thinking (0.898) and Stay Relevant and Collaboration (0.872), recorded values above the stricter 0.85 threshold, warranting explicit discussion.

These elevated HTMT values are theoretically expected and contextually interpretable. The three Industry 4.0 competency constructs (Collaboration, Critical Thinking, and Stay Relevant) were deliberately drawn from a single integrated competency framework developed by the Institute for Adult Learning Singapore (Freebody, 2023), which conceptualizes these capabilities as interrelated and mutually reinforcing dimensions of a broader Industry 4.0 workforce readiness profile rather than as fully independent constructs. Their theoretical overlap is therefore a reflection of the framework's design rather than a measurement artifact. In the Omani public sector context specifically, this overlap may also reflect cultural and institutional factors: employees operating within a collectivist, relationally oriented work culture may perceive and enact these competencies in a more integrated and mutually reinforcing manner, such that critical thinking is exercised collaboratively and stay relevant is pursued through socially embedded learning, blurring the experiential boundaries between constructs. This cultural dimension of competency enactment in GCC public sector contexts is consistent with observations in the broader Arab public administration literature regarding the relational and collective nature of professional practice (Abdalla & Al-Homoud, 2001; Al-Yahya, 2009).

The elevated HTMT values also raise a legitimate conceptual question about whether a single higher-order Industry 4.0 competency factor might provide an alternative and parsimonious representation of the data. This possibility is acknowledged as theoretically plausible and worthy of future investigation. However, the present study retains the three-construct structure for two reasons. First, the theoretical framework and the competency instrument from which the measures were adopted (Freebody, 2023) explicitly distinguish these as separate, domain-specific competency clusters with distinct behavioral manifestations, a conceptual distinction that a single aggregate factor would collapse and obscure. Second, the structural model produced meaningful and theoretically differentiated results across the three constructs, with Collaboration emerging as the strongest predictor and the only construct whose relationship with Job Performance was significantly moderated by Leadership Support. This pattern of differential effects would not be recoverable from a single aggregate competency factor, and its theoretical and practical significance would be lost. Nonetheless, future research examining whether a higher-order global Industry 4.0 competency factor provides equivalent or superior fit in different organisational and cultural contexts would constitute a valuable contribution to the competency measurement literature.

Overall, the HTMT results provide sufficient support for discriminant validity at the main construct level, and the elevated values among the Industry 4.0 competency constructs are interpreted as theoretically coherent rather than problematic, consistent

with established guidance for hierarchical component models in PLS-SEM (Hair et al., 2023; Sarstedt et al., 2019).

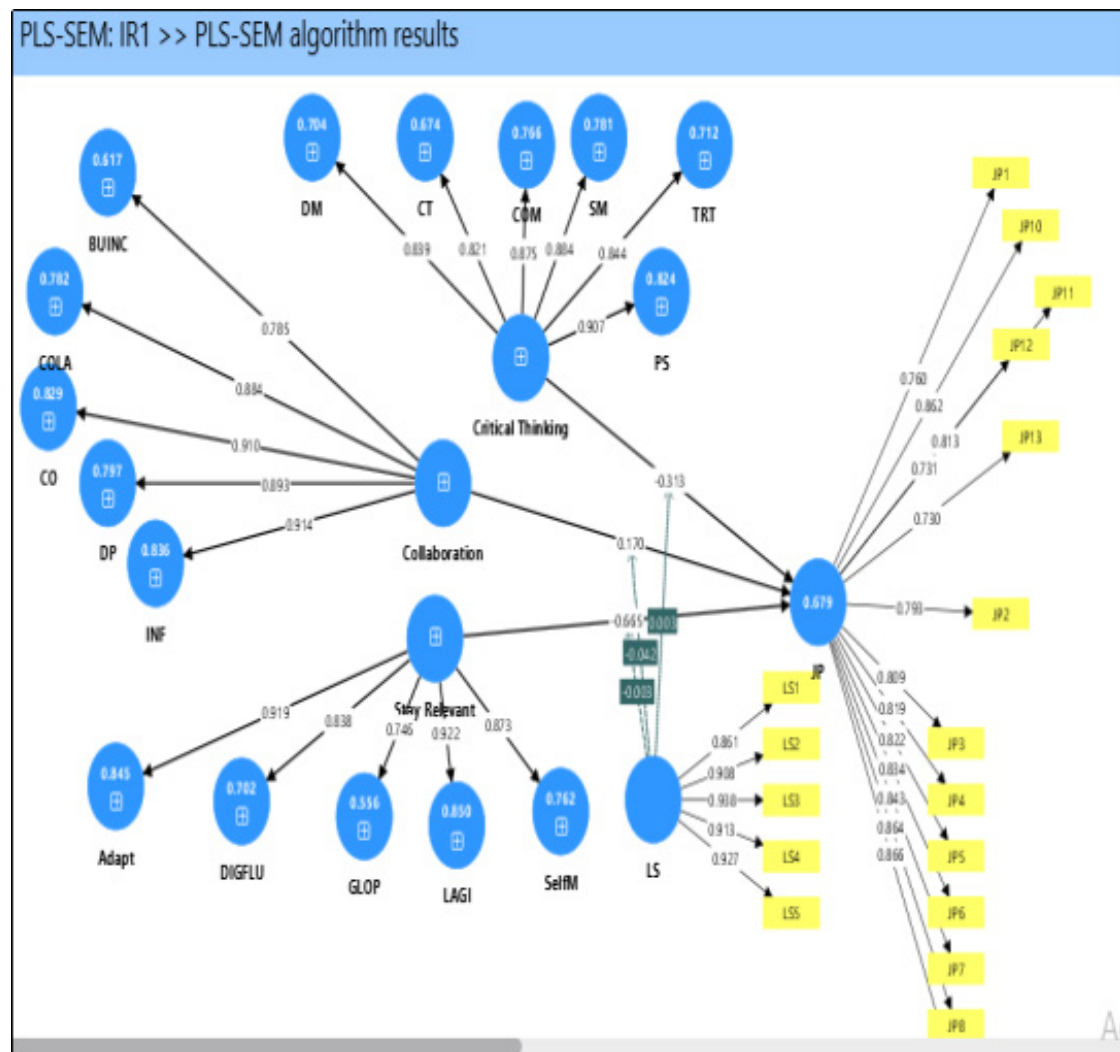


Figure 4.1. Measurement Model

Table 4.2. Measurements Model Results

First Order	Second Order Construct	Item Code	Value	CR	AVE
Adaptability	STAY RELEVANT	ADAP1	0.816	0.564	0.864
		ADAP2	0.893		
		ADAP3	0.907		
		ADAP4	0.909		
		ADAP5	0.870		
Digital Fluency	DIGITAL FLUENCY	DIGFLU1	0.879	0.564	0.864
		DIGFLU2	0.893		
		DIGFLU3	0.935		
		DIGFLU4	0.916		
		DIGFLU5	0.832		

Continuation Table:

First Order	Second Order Construct	Item Code	Value	CR	AVE
Global Perspective		GLOP1	0.839		
		GLOP2	0.867		
		GLOP3	0.878		
		GLOP4	0.872		
		GLOP5	0.904		
Learning Agility		LAGI1	0.875		
		LAGI2	0.871		
		LAGI3	0.892		
		LAGI4	0.868		
		LAGI5	0.845		
Self-management		SELFM1	0.86		
		SELFM2	0.89		
		SELFM3	0.877		
		SELFM4	0.875		
		SELFM5	0.843		
Customer Orientation	COLLABORATION	CO1	0.856	0.603	0.882
		CO2	0.896		
		CO3	0.907		
		CO4	0.893		
		CO5	0.872		
Develop People		DP1	0.859		
		DP2	0.823		
		DP3	0.878		
		DP4	0.861		
		DP5	0.808		
collaboration		COLA1	0.832		
		COLA2	0.825		
		COLA3	0.84		
		COLA4	0.837		
		COLA5	0.837		
Building Inclusive		BUINC1	0.723		
		BUINC2	0.833		
		BUINC3	0.889		

Continuation Table:

First Order	Second Order Construct	Item Code	Value	CR	AVE
Influence		BUINC4	0.885		
		BUINC5	0.731		
		INF1	0.791		
		INF2	0.835		
		INF3	0.810		
		INF4	0.850		
		INF5	0.738		
Communication	CRITICAL THINKING	COM1	0.847	0.556	0.882
		COM2	0.875		
		COM3	0.898		
		COM4	0.847		
		COM5	0.887		
CREATIVE THINKING		CT1	0.748		
		CT2	0.816		
		CT3	0.866		
		CT4	0.808		
		CT5	0.831		
DECISION MAKING		DM1	0.685		
		DM2	0.859		
		DM3	0.838		
		DM4	0.801		
		DM5	0.759		
Sense Making		SM1	0.843		
		SM2	0.894		
		SM3	0.91		
		SM4	0.903		
		SM5	0.878		
Problem Solving		PS1	0.8		
		PS2	0.884		
		PS3	0.886		
		PS4	0.893		
		PS5	0.882		
Transdisciplinary Thinking					

Continuation Table:

First Order	Second Order Construct	Item Code	Value	CR	AVE
		TRT1	0.787		
		TRT2	0.75		
		TRT3	0.895		
		TRT4	0.856		
		TRT5	0.853		
Leadership Support		LS1	0.861	0.953	0.828
		LS2	0.908		
		LS3	0.938		
		LS4	0.913		
		LS5	0.927		
Job Performance		JP1	0.760	0.958	0.66
		JP10	0.862		
		JP11	0.813		
		JP12	0.731		
		JP13	0.730		
		JP2	0.793		
		JP3	0.809		
		JP4	0.819		
		JP5	0.822		
		JP6	0.834		
		JP7	0.843		
		JP8	0.864		
		JP9	0.866		

Table 4.3. Discriminant validity

CONSTRUCT	COLLAB.	CRIT. THINK.	JP	LS	STAY REL.
COLLABORATION	—				
CRITICAL THINKING	0.835	—			
JOB PERFORMANCE (JP)	0.723	0.786	—		
LEADERSHIP SUPPORT (LS)	0.402	0.451	0.415	—	
STAY RELEVANT	0.872	0.898	0.839	0.507	—

4.3 Structural Model Assessment

Once the measurement model's reliability and validity were confirmed, the

structural model was assessed to test the hypotheses and explore the relationships among the latent variables. Following PLS-SEM guidelines, the evaluation concentrated on path coefficients, their significance levels, and the model's ability to explain variance (Hair et al., 2021). Bootstrapping with an adequate number of resamples was used to determine standard errors, t-values, and p-values.

4.3.1 Path Coefficients and Hypothesis Testing

The structural model was evaluated using bootstrapping with 10,000 resamples and a 90% confidence interval. The model explained 67.9% of the variance in Job Performance ($R^2 = 0.679$), indicating strong explanatory power. **Table 4.4** and **Figure 4.2** present the path coefficients, t-values, p-values, and confidence intervals for all hypothesized relationships.

With respect to the direct effects, all three Industry 4.0 competency constructs demonstrated positive relationships with Job Performance. Collaboration produced the strongest and most statistically significant effect ($\beta = 0.349$, $t = 2.721$, $p = 0.003$), with a confidence interval entirely above zero (0.132 to 0.553), confirming H1. Stay Relevant also demonstrated a significant positive effect ($\beta = 0.166$, $t = 1.772$, $p = 0.038$), with a confidence interval ranging from 0.012 to 0.322, supporting H3. Critical Thinking showed a positive relationship with Job Performance ($\beta = 0.176$, $t = 1.327$, $p = 0.092$), significant at the 10% level adopted in this study, with a confidence interval of 0.054 to 0.382 excluding zero, partially supporting H2.

Regarding the moderating effects of Leadership Support, only the interaction with Collaboration was statistically significant ($\beta = 0.173$, $t = 2.275$, $p = 0.011$, CI: 0.048 to 0.292), indicating that Leadership Support meaningfully amplifies the positive effect of Collaboration on Job Performance, thus supporting H4. The moderating effects of Leadership Support on the Critical Thinking–Job Performance relationship ($\beta = 0.008$, $t = 0.080$, $p = 0.468$, CI: -0.154 to 0.187) and on the Stay Relevant–Job Performance relationship ($\beta = -0.021$, $t = 0.250$, $p = 0.401$, CI: -0.164 to 0.113) were not statistically significant, as both confidence intervals included zero. Accordingly, H5 and H6 were not supported.

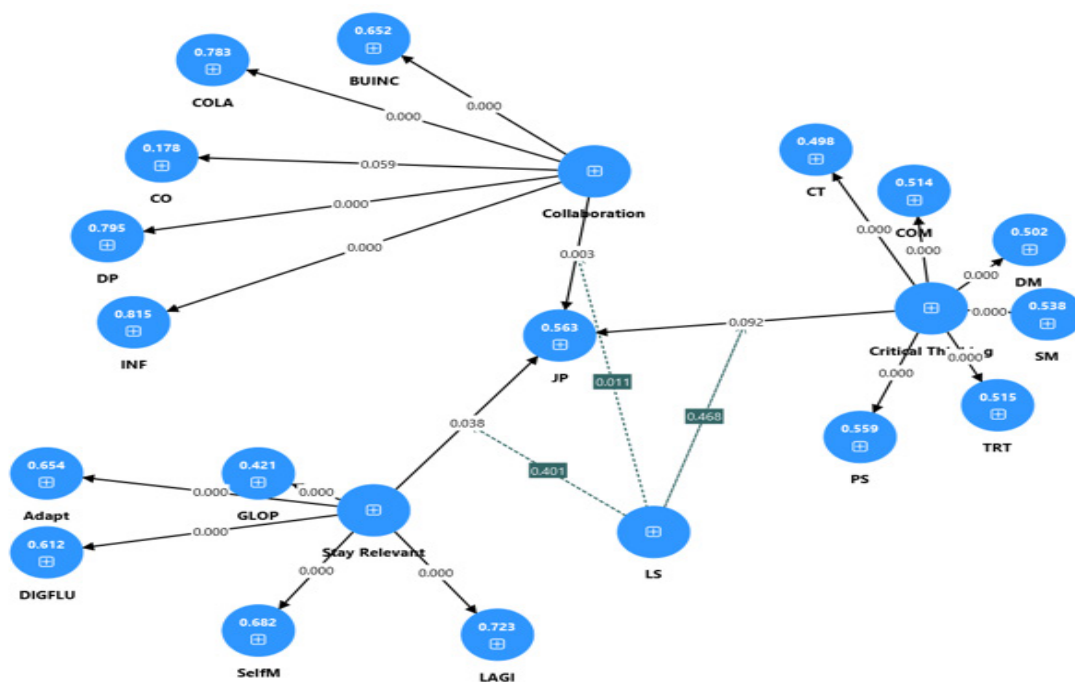


Figure 4.2. Structure Model Assessment

Table 4.4. Hypotheses Testing

Hypotheses	Relationship	Std.Beta	St_dev	T-values	P-value	PCI LL	PCI UL	Decision
H1	Collaboration → Job Performance	0.349	0.128	2.721	0.003	0.132	0.553	Supported
H2	Critical Thinking → Job Performance	0.176	0.132	1.327	0.092	0.054	0.382	Supported at 10% level
H3	Stay Relevant → Job Performance	0.166	0.076	1.772	0.038	0.012	0.322	Supported
H4	Leadership Support × Collaboration → Job Performance	0.173	0.105	2.275	0.011	0.048	0.292	Supported
H5	Leadership Support × Critical Thinking → Job Performance	0.008	0.084	0.080	0.468	-0.154	0.187	Not Supported
H6	Leadership Support × Stay Relevant → Job Performance	-0.021	0.094	0.250	0.401	-0.164	0.113	Not Supported

Note: The present author uses a 90% confidence interval with a bootstrapping of 10,000

5. Discussion

5.1 Collaboration and Job Performance (H1)

The results confirm a significant positive effect of Collaboration on Job Performance ($\beta = 0.349$, $t = 2.721$, $p = 0.003$), supporting H1 and establishing it as the strongest direct predictor in the model. This finding is consistent with a substantial body of empirical evidence positioning collaboration as a fundamental driver of individual and organizational performance (Gratton & Erickson, 2007; Jensen et al., 2018; Hoegl & Gemuenden, 2001). Recent studies similarly confirm that teamwork and cooperative behavior enhance employee performance through improved communication, trust, and shared goal achievement across multiple sectors (Sanyal & Hisam, 2018; Bokaii, 2023; Nanda et al., 2025). In the Industry 4.0 context specifically, Oztemel and Gursev (2020) emphasized collaboration as one of the most essential competencies for employees in digitally connected environments, a position reinforced by the present findings.

Several contextual factors help explain this result. First, public service delivery in Oman increasingly demands cross-functional coordination and joint problem-solving as government entities pursue digital transformation under Vision 2040, creating conditions in which collaborative competency directly translates into performance gains. Second, the highly tenured sample, with 94.6% reporting more than ten years of experience, may strengthen rather than diminish the collaboration–performance link, as experienced employees draw on well-developed collaborative networks and institutional relationships to coordinate effectively and resolve challenges efficiently (Ericsson et al., 1993). Third, the collectivist cultural orientation of the Omani workplace, which values interpersonal relationships and group cohesion, likely reinforces collaborative behavior and increases its practical impact on performance outcomes (Abdalla & Al-Homoud, 2001). It is also worth noting that collaboration was operationalized as a second-order construct encompassing

five dimensions, namely customer orientation, developing people, communication, building inclusivity, and influence, meaning the observed effect captures the holistic expression of collaborative competency rather than any single dimension.

5.2 Critical Thinking and Job Performance (H2)

Critical Thinking showed a positive relationship with Job Performance ($\beta = 0.176$, $t = 1.327$, $p = 0.092$), significant at the 10% level, providing partial support for H2. This finding aligns with the broader literature linking critical thinking to improved work performance across diverse occupational contexts, including nursing (Ateş et al., 2023), dental hygiene (Lee et al., 2017), and organizational performance more broadly (Khas et al., 2023). Facione (2011) and Paul and Elder (2019) similarly argued that employees with strong critical thinking capabilities are better positioned to make high-quality decisions and respond effectively to complex work demands. The World Economic Forum (2020) and Schleicher (2015) identified critical thinking as one of the most important competencies for future workforce performance in Industry 4.0 environments.

The modest magnitude of the effect, however, points to important contextual constraints. The hierarchical and procedurally structured nature of the Omani public sector may limit the formal channels through which critical thinking translates into measurable performance outcomes, as employee performance is often evaluated against standardized compliance criteria rather than cognitive initiative (Al-Yahya, 2009; Al-Hamadi et al., 2007). Additionally, operationalizing Critical Thinking as a broad second-order construct spanning creative thinking, decision-making, problem-solving, sense-making, and transdisciplinary thinking may obscure the differential contributions of individual dimensions, some of which may have stronger direct links to performance than others. The highly tenured sample may also contribute to a ceiling effect, as critical thinking competencies may already be deeply embedded in experienced employees' professional practice, reducing the visibility of marginal contributions (Ericsson et al., 1993).

5.3 Stay Relevant and Job Performance (H3)

Stay Relevant had a significant positive effect on Job Performance ($\beta = 0.166$, $t = 1.772$, $p = 0.038$), supporting H3. This finding aligns with growing empirical evidence linking adaptability, learning agility, and digital competence to stronger Job Performance. The World Economic Forum (2020) and DeNisi and Murphy (2017) emphasize that employees who proactively update their skills in response to technological change are better positioned to sustain high-quality performance. Serena et al. (2025) and Wolor et al. (2025) demonstrate that learning agility directly enhances employee performance in digitally transforming environments, while Chong and Zainal (2024) and Park and Park (2020) confirm that digital literacy and adaptive behavior are positively associated with Job Performance in changing work settings.

The modest effect size warrants consideration. Performance appraisal systems in the Omani public sector continue to emphasize procedural compliance and task completion over adaptability and digital innovation, potentially constraining the observable performance returns of stay-relevant competencies (Al-Hamadi et al., 2007; Al-Yahya, 2009). A transitional dynamic may also be at play: drawing on the J-curve model of organizational learning (Anderson, 2016), employees actively developing new digital competencies may be in an early stage of integration, where performance gains have not yet fully materialized. Furthermore, Saputra (2024, 2025) highlighted that the pathway from stay-relevant to performance may be partially mediated by learning agility and employee agility, suggesting that the direct effect

captured here may underestimate the construct's full performance value.

5.4 The Moderating Role of Leadership Support (H4, H5, H6)

Leadership Support significantly moderated the Collaboration–Job Performance relationship ($\beta = 0.173$, $t = 2.275$, $p = 0.011$), supporting H4 and indicating that the performance benefits of collaborative competency are amplified under active, supportive leadership. This finding aligns with transformational leadership theory (Bass & Avolio, 1994), which posits that inspiring, motivating leadership creates conditions in which individual capabilities are more fully leveraged for performance. Sürücü et al. (2022) similarly demonstrated that leadership support serves as a boundary condition that enhances performance by bolstering self-efficacy, while Gebremedhn et al. (2022) showed that perceived organizational support amplifies the positive effects of human capital on performance, though selectively across competency types. In the Omani public sector, where hierarchical structures shape the expression of collaborative behavior, leaders who actively model, enable, and reward collaboration through team-based work arrangements and open communication channels are critical to converting collaborative competency into measurable performance gains (Edmondson, 1999; Han et al., 2020).

In contrast, Leadership Support did not significantly moderate the relationships involving Critical Thinking ($\beta = 0.008$, $p = 0.468$) or Stay Relevant ($\beta = -0.021$, $p = 0.401$), leaving H5 and H6 unsupported. This selectivity is consistent with the broader literature recognizing that Leadership Support does not uniformly enhance all performance domains but is contingent on the nature of the competency and the contextual conditions at play (Zhang et al., 2023; Nguyen et al., 2025). Critical Thinking and Stay Relevant are inherently more individually driven competencies, relying on internal cognitive processes and personal developmental commitment that are less dependent on direct leadership facilitation (Saputra, 2024; Wolor et al., 2025). The high power-distance culture characteristic of Arab public sector organisations may further constrain leadership's moderating potential for individually driven competencies, as leadership in such contexts tends to operate through administrative supervision rather than developmental empowerment (Hofstede, 2001; Dorfman et al., 2012). It is also possible that Leadership Support functions as an antecedent rather than a moderator for these competencies, shaping initial motivation to develop Critical Thinking and Stay Relevant skills rather than amplifying their translation into performance outcomes; a pathway not captured in the current model that represents a meaningful direction for future research (Nguyen et al., 2025).

Overall, the moderation findings present a theoretically nuanced picture: Leadership Support matters, but its enabling role is selective rather than universal (Gebremedhn et al., 2022; Sürücü et al., 2022). Its amplifying effect on Collaboration underscores the importance of enabling leadership in the Omani public sector, while the non-significant effects for the other two competencies suggest that Critical Thinking and Stay Relevant require different organizational enablers, including job autonomy, digital infrastructure, and performance systems that formally reward adaptability and innovation, to generate their full performance potential.

6. Implications, Conclusions, and Future Research

6.1 Theoretical Implications

This study makes several meaningful contributions to theory by empirically examining Industry 4.0 competency–performance relationships in a non-Western

public sector context and testing the moderating role of Leadership Support across multiple theoretical frameworks.

From a Human Capital Development Theory perspective (Becker, 1989; Schultz, 1961), the positive effects of all three competency constructs affirm that investments in workforce capabilities yield measurable performance returns. However, the varying effect sizes refine this theoretical position by demonstrating that performance returns on human capital investment are not uniform. The stronger effect of Collaboration suggests that socially embedded and interpersonally expressed competencies generate more immediate and observable performance gains than individually driven cognitive competencies in public sector contexts, encouraging a more differentiated application of human capital theory that accounts for the type, expression, and organisational embeddedness of the competency being developed. This finding advances HCDT by highlighting that the performance value of human capital investment is not solely a function of the competency's theoretical importance but also of its social visibility, interpersonal expressibility, and alignment with the prevailing organisational and cultural context in which it is enacted.

From a Socio-Technical Systems Theory perspective (Trist & Bamforth, 1951; Pasmore, 1988), the modest effects of Critical Thinking and Stay Relevant suggest that the social and technical conditions necessary for these competencies to fully manifest in performance outcomes may not yet be sufficiently developed in the Omani public sector. This contributes to STS theory by providing empirical evidence that the competency–performance relationship is contingent on the degree of socio-technical alignment present within the organization, and that competency development without complementary organizational infrastructure, including digital tools, flexible job design, and innovation-enabling work processes, yields constrained performance returns. The STS perspective further implies that Critical Thinking and Stay Relevant may require a higher degree of technical system maturity to generate their full performance potential, as these competencies are most powerfully expressed in digitally enabled, knowledge-intensive work environments that may not yet be fully realised across the Omani public sector.

From a Resource-Based View perspective (Barney, 1991; Wernerfelt, 1984), the findings suggest that Industry 4.0 competencies, particularly Collaboration, constitute strategically valuable human resources that meaningfully contribute to institutional effectiveness and service quality. The amplifying effect of Leadership Support on Collaboration further aligns with RBV's emphasis on socially complex, relationally embedded capabilities as sources of durable organizational value that are difficult to replicate. The more modest contributions of Critical Thinking and Stay Relevant indicate that these competencies may not yet have reached their full strategic value as organisational resources, as the complementary systems needed to leverage them, including appropriate performance measurement, digital infrastructure, and institutional flexibility, remain underdeveloped. From an RBV perspective, this suggests that the strategic value of individually driven competencies is co-produced by the organizational context rather than residing solely in the employee, and that building complementary organizational capabilities is as strategically important as developing the competencies themselves.

With respect to Contingency Theory (Lawrence & Lorsch, 1967; Fiedler, 1964), the selective moderating role of Leadership Support provides particularly important and nuanced theoretical insights that the reviewer's comment invites us to explore more fully. The finding that Leadership Support significantly amplifies

the Collaboration–Job Performance relationship but not those involving Critical Thinking and Stay Relevant advances Contingency Theory by empirically specifying the boundary conditions under which Leadership Support functions as a meaningful performance-enhancing moderator. Socially oriented and interpersonally expressed competencies appear more responsive to leadership enablement, while individually driven cognitive and developmental competencies operate through relatively autonomous pathways that are less contingent on direct leadership facilitation.

Several alternative theoretical explanations and organizational mechanisms can be proposed to account for this pattern and deepen understanding of its implications. First, Self-Determination Theory (Deci & Ryan, 1985) offers a compelling lens for understanding why Critical Thinking and Stay Relevant may not be moderated by Leadership Support. Both competencies are inherently intrinsically motivated. Employees who engage in critical reasoning and continuous self-development are typically driven by autonomous motivation, curiosity, and professional identity rather than by external social reinforcement from leaders. In Self-Determination Theory terms, these competencies are more closely aligned with autonomous rather than controlled motivation, making their expression in performance outcomes relatively independent of the social and relational conditions that Leadership Support provides. Collaboration, by contrast, depends fundamentally on interpersonal dynamics and shared social contexts that are directly shaped by leadership behavior, making it more responsive to the enabling conditions that supportive leadership creates.

Second, Ability-Motivation-Opportunity (AMO) theory (Appelbaum et al., 2000) provides a useful framework for understanding which organizational mechanisms are most likely to enable Critical Thinking and Stay Relevant to generate stronger performance returns. The AMO theory holds that employee performance is a joint function of ability, motivation, and opportunity, and that all three must be present for competencies to translate into outcomes. In the Omani public sector context, employees may possess the ability and motivation to think critically and Stay Relevant but lack the organizational opportunity to apply these competencies meaningfully. The non-significant moderation by Leadership Support for these two constructs may therefore reflect not the absence of leadership's relevance but rather the absence of the right type of enablement, specifically the provision of structured opportunities for autonomous decision-making, innovation, and digital skill application that fall outside the typical scope of Leadership Support as operationalized in this study. This suggests that the opportunity dimension of AMO, encompassing job autonomy, access to digital infrastructure, and flexible performance evaluation, may be a more powerful moderator of the Critical Thinking and Stay Relevant–performance relationships than interpersonal Leadership Support alone.

Third, Psychological Empowerment Theory (Spreitzer, 1995; Thomas & Velthouse, 1990) offers a further explanation. Psychological empowerment, encompassing perceived meaning, competence, self-determination, and impact, is widely recognized as a critical mediator through which leadership conditions influence employees' willingness and ability to apply cognitively demanding competencies in their work. It is possible that Leadership Support in the Omani public sector does not yet sufficiently activate the psychological empowerment required for Critical Thinking and Stay Relevant to translate into measurable performance gains. In high power-distance cultures characteristic of GCC public sector organizations (Hofstede, 2001; Dorfman et al., 2012), directive and administratively oriented leadership styles may provide general organizational support without creating the conditions of perceived autonomy and impact that are necessary for employees to

feel empowered to exercise independent critical judgment or to invest in self-directed development in ways that visibly enhance their performance.

Fourth, it is theoretically plausible that Leadership Support functions as an antecedent rather than a moderator for Critical Thinking and Stay Relevant. That is, supportive leadership may primarily influence employees' initial motivation and access to opportunities to develop these competencies, shaping the acquisition of skills rather than the conversion of already-developed skills into performance outcomes. This distinction between competency acquisition and competency application is theoretically important and suggests a mediated rather than moderated model in which Leadership Support → Competency Development → Job Performance represents the operative pathway for these individually driven constructs. This alternative model specification, grounded in both HCDDT and AMO theory, represents a meaningful direction for future research that could substantially advance theoretical understanding of how leadership shapes the Industry 4.0 competency–performance relationship in public sector contexts.

Finally, the study makes a methodological contribution by being among the first to empirically test this configuration of Industry 4.0 competencies using a hierarchical component structure that operationalises Collaboration, Critical Thinking, and Stay Relevant as second-order reflective constructs, extending the application of the Singapore Institute for Adult Learning competency framework (Freebody, 2023) into a new empirical setting and initiating an important theoretical debate about whether Industry 4.0 competencies are best conceptualised as integrated capability domains or as distinct sub-capabilities with differential performance effects and different sensitivity to leadership moderation.

6.2 Practical Implications and Recommendations

The findings carry several important practical implications for managers, human resource practitioners, and policymakers in the Omani public sector.

First, organizations should prioritise Collaboration as a core performance strategy. The finding that Collaboration is the strongest predictor of Job Performance, further amplified by Leadership Support, suggests that ministries and public institutions should embed collaborative competency development at the centre of their workforce planning, job design, and performance management frameworks. This includes creating structured cross-functional teamwork opportunities, incorporating collaborative objectives into appraisal systems, and designing work environments that facilitate knowledge sharing and collective problem-solving.

Second, developing enabling leadership is essential. The significant moderating effect of Leadership Support on the Collaboration–Job Performance relationship demonstrates that investing in employees' collaborative skills must be accompanied by deliberate leadership development. Public sector organisations should invest in programmes that equip managers with coaching-oriented, psychologically safe, and participative leadership styles, shifting away from purely administrative and supervisory functions toward more empowering approaches that actively model and reward collaborative behaviour.

Third, training programmes should be redesigned as application-oriented interventions. The modest effect sizes for Critical Thinking and Stay Relevant suggest that generic competency-building is insufficient. Organizations should develop targeted programs that directly connect skill development to real workplace challenges, linking Critical Thinking, digital fluency, and learning agility training to concrete job tasks, process improvement initiatives, and decision-making scenarios

within specific public sector roles (Al-Haimi et al., 2024).

Fourth, performance management systems require modernisation. A persistent disconnect between the competencies organisations claim to value and the behaviours they actually measure and reward will undermine competency development investments. Performance appraisal systems should be redesigned to formally recognise and reward collaborative contribution, innovative thinking, adaptability, and continuous learning alongside traditional compliance and task completion criteria.

At the policy level, the findings support the strategic emphasis of Oman's Vision 2040 on human capital development and digital transformation, while also signalling that competency development programmes must be accompanied by complementary institutional reforms. Policymakers should treat leadership development, performance management modernisation, and digital infrastructure investment as mutually reinforcing strategic priorities rather than isolated initiatives, ensuring that the enabling conditions necessary for Industry 4.0 competencies to generate their full performance potential are systematically developed across the Omani public sector.

6.3 Limitations and Future Research

This study has several limitations. The cross-sectional design limits causal inference, and future longitudinal research would better capture how competency–performance relationships evolve as digital transformation deepens in the Omani public sector. The exclusive reliance on self-reported data introduces the risk of common method and social desirability bias, and future studies should supplement self-report measures with supervisor-rated or objective performance data. The sample was also demographically skewed, with 90.8% male, 94.6% having more than ten years of public sector experience, and 98.2% aged above 35; this profile likely reflects the seniority-weighted structure of the sampling frame within Omani ministries rather than the sector's actual demographic composition, but it also means the findings are most directly applicable to experienced, mid-to-senior career male employees and may not fully capture how Industry 4.0 competencies relate to performance among female, younger, or less experienced employees, who may differ in digital fluency, career motivation, or exposure to competency-building opportunities. The single-sector, single-country focus similarly constrains the transferability of findings to private-sector or other national contexts, and comparative studies across GCC countries and developing-economy public sectors would be particularly valuable, alongside deliberate oversampling of more diverse age, gender, and tenure groups to test whether the observed relationships hold across the broader public sector workforce.

The structural model also examined a specific set of relationships and did not account for potentially important mediating variables, including job autonomy, employee engagement, psychological safety, digital infrastructure readiness, and innovation climate, that may shape how competencies translate into performance. Future research incorporating these variables would offer a more complete understanding of the mechanisms and boundary conditions through which Industry 4.0 competencies influence job performance. Additionally, future studies should explore alternative specifications for Leadership Support, as a direct predictor, mediator, or antecedent rather than solely as a moderator, to better understand the full range of pathways through which leadership influences the competency–performance relationship. Finally, testing the first-order dimensions of the competency constructs separately, rather than only as second-order aggregates, would provide more granular guidance for targeted competency development interventions and help identify which

specific dimensions of Critical Thinking and Stay Relevant are most practically relevant to performance improvement in public sector settings.

6.4 Conclusion

This study set out to examine whether Industry 4.0 competencies improve Job Performance in the Omani public sector and to investigate the moderating role of Leadership Support in these relationships. The findings provide broad empirical support for the relevance of Industry 4.0 competencies as drivers of Job Performance, with Collaboration, Critical Thinking, and Stay Relevant all demonstrating positive effects. Collaboration emerged as the dominant performance predictor, further amplified by Leadership Support, while Critical Thinking and Stay Relevant contributed positively but more modestly, reflecting the influence of contextual and structural constraints within the Omani public sector. The selective, rather than universal, moderating role of Leadership Support advances theoretical understanding of the boundary conditions under which Leadership Support functions as a performance-enhancing enabler within Industry 4.0 competency frameworks.

Taken together, these findings affirm that Industry 4.0 competency frameworks can generate meaningful performance benefits in non-Western, institutionally complex public sector environments, while also demonstrating that their full impact depends on enabling leadership conditions, aligned organizational systems, and supportive institutional infrastructure. As Oman continues its digital transformation journey under Vision 2040, the strategic development of Industry 4.0 competencies, particularly Collaboration, combined with deliberate investment in enabling leadership and modernized performance management systems, represents a coherent and evidence-based pathway toward a higher-performing, more adaptive, and future-ready public sector workforce.

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